

# Exponent



**Statement of Work for Evaluation  
of Natural Attenuation at Boeing  
Realty Corporation, Former C-6  
Facility, Torrance, California**

Prepared for

Ogden Environmental and Energy Services Co.  
San Diego, CA

and

Boeing Realty Corporation  
Long Beach, CA



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Prepared for

Ogden Environmental and Energy Services Co.  
5510 Morehouse Dr.  
San Diego, CA 92120

and

Boeing Realty Corporation  
3760 Kilroy Airport Way, Suite 500  
Long Beach, CA 90806

Prepared by

Exponent  
15375 SE 30th Place, Suite 250  
Bellevue, WA 98007

January 2001

A handwritten signature in cursive script, appearing to read "Leo Schuman", with a long, sweeping horizontal line extending to the right.

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## Acronyms and Abbreviations

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DCA	dichloroethane
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
MNA	monitored natural attenuation
ORP	oxidation/reduction potential
OSWER	Office of Solid Waste and Emergency Response
<i>p</i> -CBSA	<i>p</i> -chlorobenzene-sulfonic acid
PCE	tetrachloroethene
QA/QC	quality assurance and quality control
SOP	standard operating procedure
SOW	statement of work
Tait	Tait Environmental
TCA	trichloroethane
TCE	trichloroethene
VOC	volatile organic compound

## 1. Introduction

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This statement of work (SOW) describes the procedures for collecting data to assess the effectiveness of natural attenuation in treating contaminated groundwater beneath Boeing Realty Corporation, former C-6 facility. The chemicals of concern are chlorinated and non-chlorinated solvents. Boeing Realty Corporation is currently involved in a voluntary corrective action for soil and groundwater beneath the C-6 facility.

Exponent recently completed a preliminary evaluation of the effectiveness of natural attenuation<sup>1</sup> to serve as a portion of the remedy (Exponent 2000). Results from this preliminary evaluation suggest that natural attenuation may be contributing to contaminant mass removal and the stability of the contaminant plume that originates near the former location of Building 1. Groundwater conditions beneath the C-6 facility may satisfy the first two lines of evidence (mass loss and the presence of daughter products and geochemical indicator parameters) for the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response (OSWER) directive regarding the use of monitored natural attenuation (MNA) at contaminated sites (U.S. EPA 1999). However, complete geochemical data that would be required to document conditions conducive to potential biodegradation processes for these compounds, or that would serve as direct evidence of biodegradation, are not currently available. Biodegradation brings about measurable changes in the groundwater chemistry in affected areas. Additional geochemical data from source wells, and wells upgradient, downgradient, transgradient, and outside the affected area, will enable quantitative evaluation of intrinsic biodegradation (including the effects of sorption and aerobic and anaerobic biodegradation) taking place at the C-6 facility. This SOW describes the additional data that needs to be collected to further evaluate MNA as a viable and applicable remedial technology for the C-6 facility.

Field activities will consist of collecting field measurements of key groundwater variables (e.g., dissolved oxygen) and groundwater samples from selected onsite monitoring wells. Laboratory analysis will be performed for general chemistry parameters. All field and laboratory work should be conducted in accordance with EPA's natural attenuation protocol for chlorinated solvents (U.S. EPA 1998) and EPA's

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<sup>1</sup> Natural attenuation is achieved when naturally occurring attenuation mechanisms, such as biodegradation (aerobic and anaerobic), in combination with physical mechanisms (e.g., dispersion), bring about a reduction in the total mass, toxicity, mobility, volume, or concentration of a contaminant in soil or groundwater. Intrinsic biodegradation is the major component of natural attenuation.

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OSWER directive on MNA (U.S. EPA 1999). The SOW is organized into the following sections:

- Section 1, *Introduction*
- Section 2, *Indicator Parameters*
- Section 3, *Field Sampling and Analytical Program*
- Section 4, *References.*

## **2. Indicator Parameters**

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Natural attenuation of chlorinated and nonchlorinated solvents occurs under specific geochemical conditions in groundwater. Groundwater samples will be analyzed for selected field and laboratory parameters to characterize geochemical conditions and determine the presence or absence of geochemical indicators of natural attenuation. These parameters and the rationale for measuring them are described below.

### **2.1 Field Parameters**

Groundwater samples will be analyzed for dissolved oxygen and oxidation/reduction potential (ORP), temperature, pH, and specific conductance. Dissolved oxygen and ORP will be measured during well purging to assess the redox conditions in groundwater (e.g., anaerobic/aerobic). Dissolved oxygen concentrations provide an indication of potential anaerobic conditions. Certain biogeochemical processes are believed to occur within specific ORP ranges. Therefore, ORP measurements provide a qualitative indication of the types of microbial activities to be expected (e.g., aerobic oxidation, nitrate-, iron-, or sulfate-reduction, acetogenesis, or methanogenesis). Temperature, pH, and specific conductance will be measured during well purging to document that the groundwater sampled is representative of the aquifer.

### **2.2 Volatile Organic Compounds**

Chlorinated volatile organic compounds (VOCs) and related daughter products detected in site groundwater include trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), chloroform, *cis*- and *trans*-1,2-dichloroethene (*cis*-DCE, *trans*-DCE), 1,1-dichloroethene (1,1-DCE) and 1,1-dichloroethane (1,1-DCA). The nonchlorinated VOCs benzene and toluene are present in concentrations greater than 100 µg/L (Kennedy/Jenks 2000a). Groundwater samples will be analyzed for VOCs to document their current distribution in the groundwater relative to source areas and to determine to what extent they are biodegrading.

### **2.3 General Chemistry Parameters**

Groundwater samples will be analyzed for selected general chemistry parameters to assess the types and location of microbial activities occurring in groundwater and to provide additional evidence of biodegradation. For example, the depletion of sulfate can be used to assess the activity of sulfate-reducing bacteria. Decomposition of organic compounds and dechlorination of chlorinated VOCs may be detected by changes in the alkalinity and chloride concentrations in groundwater, respectively. General chemistry



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parameters will include alkalinity, dissolved iron and manganese, nitrate/nitrite, sulfate, chloride, total organic carbon, and the dissolved hydrocarbon gases methane, ethene, and ethane. These parameters are all included in the natural attenuation protocol for chlorinated solvents (U.S. EPA 1998). Parameters suggested in that protocol but not included here are sulfide and hydrogen. It is not likely that sulfide is present at this site, nor is it likely that it would be detected if it were present. Hydrogen is considered optional in the protocol.

### 3. Field Sampling and Analytical Program

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This section identifies the wells from which groundwater samples will be collected and describes methods for collecting the samples for field or laboratory analysis. Proposed data collection activities are to be conducted concurrently with the annual groundwater monitoring event at the site in January 2001.

#### 3.1 Selected Groundwater Monitoring Wells

There are four plumes onsite. One plume containing TCE, TCA, chloroform, *cis*-DCE, *trans*-DCE, 1,1-DCE, 1,1-DCA, toluene, and benzene is located near Building 36 and the former location of Building 1 (Building 1 plume). The second plume contains TCE and 1,1-DCE and is located near Building 19 (Building 19 plume). The third plume contains TCE, *cis*-DCE, and chloroform and is located in the vicinity of monitoring well TMW-12 (TMW-12 plume) and the southern property boundary between Boeing and the Montrose Superfund site. Chlorobenzene and *p*-chlorobenzene-sulfonic acid (*p*-CBSA) are also present in the downgradient portion of the TMW-12 plume, although concentrations might not exceed 100 µg/L (Kennedy/Jenks 2000a). A fourth plume containing primarily TCE and minor amounts of tetrachloroethene (PCE) is located at the boundary of the Boeing and Industrial Light Metals properties.

The natural attenuation protocol for chlorinated solvents suggests well locations upgradient, downgradient, and transgradient, as well as several in the plume itself (U.S. EPA 1998). A source area well and deeper wells should be included where appropriate. Suggested wells for sampling and analysis for the Building 1 plume are as follows:

- Upgradient well, outside of the plume
  - WCC-11s
- Downgradient wells, within the plume
  - WCC-6s
  - TMW-7
  - TMW-4
- Downgradient well, beyond or at downgradient edge of plume
  - TMW-6

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- Transgradient wells, outside or at the edge of the plume
  - WCC-5s
  - WCC-12s
  - TMW-9
- Source wells
  - WCC-3s
  - WCC-3d
  - TMW-2.

A comparable suite of wells is not available for the Building 19 and TMW-12 plumes. However, installation of additional wells is not recommended at this time. A natural attenuation evaluation has already been carried out for the fourth plume (Kennedy/Jenks 2000a). Additional suggested wells for sampling and analysis for the Building 19 and TMW-12 plumes are as follows:

- Source and/or downgradient wells for the Building 19 plume
  - TMW-3
  - TMW-5
- Source and/or downgradient wells for the TMW-12 plume
  - TMW-12
  - XMW-9.

VOCs and field parameters, including dissolved oxygen, will be collected from the majority of the additional wells onsite, as part of the annual event. Well locations and a description of well construction were provided in the draft groundwater monitoring work plan for 2000 (Kennedy/Jenks 2000b).

### 3.2 Field Activities

Field activities will be performed by Tait Environmental (Tait) with the assistance of England Geosystems. Standard operating procedures (SOPs) for all sampling activities, including decontamination procedures, will be provided by England Geosystems. Field quality assurance and quality control (QA/QC) procedures, equipment decontamination procedures, management of investigation derived wastes, and field health and safety will be the responsibility of Tait and England Geosystems. General suggestions on equipment

calibration, well purging and sample collection methods, analytical parameters, and QA/QC and field data reporting are provided below.

### **3.2.1 Equipment Calibration and Procedures**

All equipment, including water level meters and sampling pumps, will be operated in accordance with the manufacturers' instructions. Water quality meters will be calibrated at least daily, in accordance with the manufacturers' instructions.

### **3.2.2 Well Purging Methods**

Sampling equipment will be decontaminated prior to each sampling event. Groundwater purging will be conducted with a low-flow pump prior to collection of groundwater samples. Dedicated low-density polyethylene discharge tubing will be used for each well. To minimize turbidity and the potential for suspension of particulates during purging and sampling, the tubing will be placed in the upper portion of the water column during purging. Flow from the purge tube will be directed into a flow-through cell and allowed to discharge from the cell directly to a secondary containment container. Field parameter measurements for pH, temperature, specific conductance, dissolved oxygen, and ORP will be collected at every purge volume. Purging should consist of a minimum of three well casing volumes, or the volume required for equilibration of field parameters, whichever is greater.

### **3.2.3 Sample Collection Methods**

Wells should be sampled from "clean" to "dirty" if possible, in order to minimize the need for extensive decontamination procedures. Pre-labeled groundwater sample containers will be filled directly from the pump discharge tubing. Sample bottles will immediately be placed on ice in a cooler.

### **3.2.4 Analytical Parameters**

Groundwater samples will be submitted to a fixed base analytical laboratory for analysis. Suggested methods, minimum limits of quantitation, and sample volumes, containers, and methods of preservation are shown in Table 1. If a local laboratory cannot be found that can meet these detection limits for methane, ethene, and ethane, it is suggested that the samples be sent to the Organic Geochemistry Laboratory at the University of Waterloo. Their contact information can be obtained from Exponent.

**Table 1. Summary of groundwater analytical methods to evaluate the potential for natural attenuation of chlorinated solvents at the Boeing Realty Corporation, former C-6 facility<sup>a</sup>**

Analysis	Method/Reference	MLQ	Location		Sample Volume/Container/ Preservation
			Field	Lab	
Dissolved oxygen	Dissolved oxygen meter	0.2 mg/L	X		Measure in flow-through cell or overflow container
Oxidation reduction potential (ORP)	A2580B field probe, direct reading	±350 mV	X		Measure in flow-through cell or overflow container
Temperature	Field probe, direct reading	0°C	X		Measure in flow-through cell or overflow container
pH	Field probe, direct reading	0.1 standard units	X		Measure in flow-through cell or overflow container
Conductivity	Field probe, direct reading	50 $\mu$ S/cm <sup>2</sup>	X		Measure in flow-through cell or overflow container
Alkalinity	310.1	50 mg/L		X	250 mL plastic bottle (ask laboratory)
Iron(II)	6010B	0.5 mg/L		X	100 mL glass or plastic bottle using low-flow sampling methods, adjust pH to 2 with nitric acid
Aromatic and chlorinated hydrocarbons	SW8260A	MCLs		X	40 mL VOA vial cooled to 4°C, adjust pH to 2 with hydrochloric acid
Methane, ethane, ethene	Kampbell et al. (1989) or SW3810 modified	1 $\mu$ g/L		X	40 mL VOA vial, add sulfuric acid to pH <2, cool to 4°C (check with selected laboratory regarding need for preservative)
Major cations and manganese	6010B	1 mg/L		X	100 mL glass or plastic bottle using low-flow sampling methods, adjust pH to 2 with nitric acid
Nitrate/nitrite	IC method E300	0.1 mg/L		X	Glass or plastic bottle (check with laboratory for volume); add sulfuric acid to pH <2, cool to 4°C (2-day holding time if not preserved; check with laboratory)
Sulfate	IC method E300	5 mg/L		X	Glass or plastic bottle (check with laboratory for volume); cool to 4°C
Chloride	IC method E300 or SW9050	1 mg/L		X	250 mL in glass bottle
Total organic carbon	SW9060	0.1 mg/L		X	1,000 mL plastic bottle; add sulfuric acid to pH <2, cool to 4°C

**Note:** IC - ion chromatography  
MCL - maximum contaminant level  
MLQ - minimum limit of quantitation  
VOA - volatile organic analysis

<sup>a</sup> Table based on U.S. EPA (1998) (Tables 2.1 and 2.2).

### **3.2.5 Field Quality Assurance and Quality Control**

Field quality control should include two field duplicate samples with at least one taken from a well that is being sampled for natural attenuation parameters. Duplicate samples will be collected in the appropriate sample container in the same manner as the original sample. The duplicate sample will be submitted “blind” to the laboratory and analyzed for the same constituents as the original sample. Laboratory quality control samples will include blank, spike, duplicate, and laboratory control samples.

All sample containers will be provided by the laboratory and will be kept closed and in a cooler until used. As they are collected, samples will be fully labeled, recorded in the field notebook along with other pertinent collection data, and returned to coolers as soon as possible. Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4°C. Sample handling while in the field will be minimized to the greatest extent possible.

### **3.2.6 Field Data Reporting**

All field sampling activities will be documented in a field logbook and/or on field data forms as appropriate. Standard notations for all field activities should include:

- Date and time
- Sample number and identifiers (if applicable)
- Well identification
- Description of modifications from the SOW or SOP (as applicable)
- Names of field personnel conducting the activity.

## 4. References

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